GUM-BICHROMATE PHOTOGRAPHIC PRINTING AS APPLICABLE TO THE CERAMIC PROCESS

PROBLEM IN LIEU OF THESIS

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INTRODUCTION, PROBLEM, AND METHODOLOGY

INTRODUCTION

Photography on ceramics has been done successfully since 1855. Lafon de Camarsac, a Paris photographer, was the first to produce "permanent photographic images on enamel and vitrified porcelain" (1, p. 566). To achieve this he used a silver based emulsion known as the wet-collodion process introduced in 1849 by Frederick Scott Archer, a British photographer (1, p. 345).

A bichromate process evolved from the wet-collodion process through the research of Henri Garnier and Alphonse Salmon of Chartres, France. In 1860, Dr. F. Joubert used the bichromate process discovered by Garnier and Salmon to develop and patent an emulsion made from ammonium bichromate, honey, albumen, and ceramic oxides or enamels, applied by the "dusting" method. The first gum-bichromate process was produced in 1864 by J. B. Obernetter, who substituted gum arabic for the honey and albumen (1, p. 567).

Especially successful in using the gum-bichromate process for obtaining very fine photographic prints on porcelain was Justus Leth, an amateur photographer in

Vienna. A portrait of Emperor Francis Josef I printed on porcelain by Leth was immured in the cornerstone of the Austrian Museum of Art and Industries in Vienna on September 1, 1871 (1, p. 568).

For a period of approximately ten years following Camarsac's achievement, many people were involved in research concerning photography on ceramics. I believe that the interest in photography on ceramics was due to the permanence of the image not obtainable with other processes.

Several contemporary methods other than the gum-bichromate process for obtaining a permanent photographic image on a clay surface are: photosilkscreen, photodecal, and photolithography. These are transfer processes, by which an image is originally printed on another surface, such as paper or decals, and then transferred to the clay surface. Transfer processes may be adapted to enable the finished photographic print to be fired, thus making the image permanent.

The gum-bichromate process is a direct printing method, which means that the image is reproduced directly on the clay surface, the emulsion fired from approximately cone 09 to cone 10 with slight loss of detail. The direct printing process eliminates several steps that the transfer processes require.

The idea of adapting the gum-bichromate process to enable printing on a clay surface originated from a

conversation I had with a graduate photography student. He was doing gum-bichromate prints on paper and mentioned that he had "borrowed" the chemicals from the ceramic glaze room.

I had seen photographs on clay prior to this time, but the procedures for attaining these prints seemed more involved than I was willing to try. The gum-bichromate process sounded easier from the description, and the idea of printing directly on a ceramic piece interested me.

There was little information to go on for my first attempts using the gum-bichromate process, but the first test tiles provided some critical data concerning exposure time, distance from light source to printing surface, and the type of surface suitable for printing. The early pieces were quite successful and provided essential information on the effects of glazing and firing the gum-bichromate emulsion.

PROBLEM

The emphasis of this investigation pertained to further experimentation using the gum-bichromate process to make permanent photographic prints on clay.

The questions answered by this investigation were as follows:

1. Will a clay surface accept multiple emulsions and multiple development processes with little or no loss of detail?

2. Can a gum-bichromate print be accomplished using a normal 35 millimeter negative in an enlarger?

3. What is the effect of different oxides and fluxes on the emulsion?

4. What is the effect of firing on the experimental emulsions?

METHODOLOGY

My data sources were to be a minimum of twenty pots with gum-bichromate prints. Information related to the questions posed and pertinent information about each piece, such as type of clay, exposure time, and problems encountered, were kept in a written journal. Responses to each of the questions were based upon the data collected.

Chapter II is devoted to the process description and commentary on selected pieces. Chapter III includes the summary and conclusions. The formula for the gum-bichromate process is contained in Appendix A, and slides of the pieces selected for comment are listed in Appendix B.

CHAPTER BIBLIOGRAPHY

1. Eder, Josef Maria, History of Photography, New York, Columbia University Press, 1945.

CHAPTER II

PROCESS DESCRIPTION AND COMMENTARY ON SELECTED PIECES

PROCESS DESCRIPTION

The gum-bichromate process consists of gum arabic (binder), potassium bichromate or ammonium bichromate (light sensitive agent), and a colorant. Potassium or ammonium dichromate also works. Less exposure time is required for ammonium dichromate, since it is more light sensitive. Ceramic oxides, stains, glazes, and fluxes were added as colorant tests.

When exposed to light the bichromate hardens the binder, making it insoluble. The developing agent is water, and when the printed clay piece is immersed the unexposed portions of the emulsion dissolve and wash away, leaving the positive image.

The surface of the area to be printed on should be clean and dry. The surface should be porous and fired to a normal bisque temperature. I obtained poor results printing on glazed surfaces and unglazed vitrified stoneware surfaces. The emulsion does not adhere properly to these surfaces. Each print attempted on a nonporous surface printed well, but all of the emulsion washed out during development.

A white base, such as porcelain or a white slip, makes the best printing surface. The use of a light colored slip as a base and a stronger colorant in the emulsion results in a two-color print. I did not experiment as fully with color as I had intended, but fine multicolored prints are conceivable using the gum-bichromate process.

The emulsion should be applied only to the area to be printed. The emulsion may be poured on or brushed on. If it is poured on, the excess emulsion must be able to drain off, or it may never dry. One even coat of emulsion is sufficient.

The emulsion is not light sensitive when wet, but becomes so as it dries. This enables the emulsion to be applied on the clay surface in a lighted room, but it must be dried in the dark. Since the wet areas fully dissolve during development, the emulsion must dry completely.

The gum-bichromate process is a contact printing process. This means that the finished print will be only as large as the negative. Kodak Plus-X and Kodak High Speed Ectachrome 35 millimeter films were used for the original exposures. These exposures were then enlarged onto Kodalith Ortho Sheet Film Type 3 by the development techniques specified by Kodak.

Exposure can be accomplished by sunlight, arc lamp, or any very intense light source. For most of the prints 500 watt photofloods were used, placed approximately thirty

inches from the printed surface. The Kodalith film has a tendency to buckle from the heat if placed too close to the photoflood. Exposure time is anywhere from fifteen minutes to several hours, depending on the intensity of the light source. After fifteen minutes, the exposure can be checked by lifting one corner of the negative while firmly holding the negative in place. The area checked should be shaded from the light source during the inspection. The finished exposure should be quite visible before development, having become increasingly dark during the exposure.

Gum-bichromate prints can be underexposed or overexposed. Overexposure can be compensated for by overdevelopment, but underexposure cannot be compensated for by underdevelopment.

The developing agent for the process is water. Development time is five minutes or longer at a temperature of about seventy degrees Fahrenheit. After a few minutes in the developer, the development of the print can be aided by using a small brush on the unexposed areas. The exposed areas of the print become insoluble due to the light and resist dissolving when brushed.

After development the entire piece must be dried before further work is done. The print needs to be bisque fired again prior to glazing because the gum arabic makes the glaze crawl when it burns out. The tendency for this crawling depends on the thickness of the emulsion layer.

During the investigation I found that the gum-bichromate process did not always work successfully on the first attempt. I was curious whether the surface could be coated with the emulsion again, reexposed, and developed with no loss of detail. I found that increased density could be accomplished by reprinting. The clay surface first had to be dried completely before the second coat of emulsion could be applied. Then the regular exposure and development processes could be followed.

COMMENTARY ON SELECTED PIECES

The commentary on the nine pieces selected includes entry number, title, type of clay, emulsion characteristics, exposure time, and development time.

ENTRY 1: "Transvestite Lidded Box"

Stoneware, fired to cone 10

Colorants: Emulsion containing 2 grams of cobalt carbonate

Exposure times: 35 minutes, 45 minutes

Development times: 10 minutes, 10 minutes

The first exposure on this piece appeared unsuccessful. The process was repeated and was successful the second time. The image on the piece prior to firing was sharp, but after the firing, a double image resulted. Apparently the first exposure worked slightly, causing the double image. This piece was significant because I learned the necessity for

proper registration regardless of the density of the first exposure.

ENTRY 2: "Townscape Picture Frame"

Lowfire clay and lowfire glazes

Colorants: Emulsion containing 2 grams of cobalt carbonate

Exposure times: 40 minutes, 45 minutes

Development times: 10 minutes, 10 minutes

The first exposure on the "Townscape Picture Frame" piece appeared too light. The main problem with using cobalt carbonate in the emulsion was the developed print appeared very light in color, giving little indication of the color intensity inherent in the metal.

The piece was exposed a second time and the print seemed to have adequate density. The bisque fired piece was refired to burn out the gum arabic. This caused the cobalt to turn dark.

"Townscape Picture Frame" was very successful. Color intensity was excellent with little contamination of the white areas. Contamination of the white area became critical, but seemed to be resolved by increased development.

The fact that a clay surface could be reprinted was very significant. It meant that the piece would not have to be discarded if the print did not work the first time.

The purpose of the second question as stated on page 4 in Chapter I was to determine whether a print could be accomplished using a continuous tone 35 millimeter negative in an enlarger. I expanded the question to find whether a print could also be made by projection from a slide projector.

Several prints were attempted using standard enlargers with 75 watt bulbs. The prints attempted under the enlargers were exposed for six hours. Apparently the light intensity was too low because the emulsion did not become exposed and completely washed out during development. I did not use any larger bulbs in the enlargers because of what might have resulted from the increased heat of a larger bulb. It is probable that a bulb rated at a minimum of 300 watts would be required for exposure of a gum-bichromate print.

The next step was to attempt projecting a 35 millimeter continuous tone negative from a Kodak slide projector with a 300 watt bulb placed approximately 25 inches from the light sensitive surface. This projection technique exposed the emulsion slightly, but the developed print came out too light to be considered a good print. This was a significant test, in that it proved that it is possible to obtain a gum-bichromate print by projection.

The third question of the investigation dealt with the effect of different colorants and fluxes on the emulsion. The materials tested in the emulsion were cobalt carbonate,

black copper oxide, red iron oxide, a commercial reddish stain, a commercial red lowfire glaze, colemanite, and borax.

ENTRY 3: "Fat Lady Cone Vase"

Stoneware, Raku fired

Colorants: Emulsion containing 2 grams of commercial red stain

Exposure time: 60 minutes

Development time: 15 minutes

"Fat Lady Cone Vase" was successful using the commercial red stain. The term "successful" is important, because some of the prints attempted using the commercial red stain in the emulsion were too light to be considered good. The problem seemed to be that either the colorant would not stay suspended without stirring before each application, or there was insufficient colorant.

ENTRY 4: "Jesus Has A Better Life"

Stoneware, Raku fired

Colorants: Emulsion containing 3 grams of commercial red stain

Exposure time: 55 minutes

Development time: 10 minutes

"Jesus Has A Better Life" was considered successful even though the finished print did not develop properly. The words in the sign should have been dark on a white

background, as in the upper left side, but the lower right side of the sign developed as white letters on a dark background.

Application of the emulsion became a significant factor in print quality. The emulsion should be as consistent as possible if applied with a brush. Sometimes it was quite difficult to obtain a consistent coating because the emulsion was absorbed quickly by the porous clay surface. On a large surface to be coated, one side would often dry before the entire surface could be covered. This application problem seemed to be the cause of the negative/positive effect on "Jesus Has A Better Life".

ENTRY 5: "Torso Teapot #3"

Stoneware, lowfire glaze, and luster

Colorant: Emulsion containing 3 grams of red iron oxide

Exposure time: 60 minutes

Development time: 20 minutes

"Torso Teapot #3" was one of the more significant pieces completed using red iron oxide as a colorant. The print became lighter when glazed and fired. This decrease of color intensity after glaze firing shows clearly on the slides. It was due to the glaze used to cover the printed area. The glaze was supposed to be clear, but it was slightly cloudy.

ENTRY 6: "Randolph Grocery Lidded Box"

Stoneware, lowfire glaze, and luster

Colorant: Emulsion containing 3 grams of red iron oxide

Exposure time: 60 minutes

Development time: 10 minutes

"Randolph Grocery Lidded Box" was the clearest print accomplished during the investigation. The color intensity was excellent with sharp details.

The emulsion used on this piece was from the same batch that was used on "Torso Teapot #3". I did not understand how the emulsion could differ so greatly as in these two pieces, and assumed that the cause lay only in the differences in application.

Another significant fact was that the color intensity of "Randolph Grocery Lidded Box" did not change noticeably when glazed and fired. "Torso Teapot #3" and "Randolph Grocery Lidded Box" were glazed and fired exactly the same, yet "Torso Teapot #3" lightened and "Randolph Grocery Lidded Box" remained the same.

"Randolph Grocery Lidded Box" was a good example of the quality of prints attainable using the gum-bichromate process on clay.

ENTRY 7: "Fat Man and Lady Platter"

Porcelain, cone 10

Colorant: Emulsion containing 1.5 grams of black copper oxide

Exposure time: 35 minutes

Development time: 10 minutes

The copper red print attained in "Fat Man and Lady Platter" was one of the more significant tests conducted. The small amount of copper used was sufficient for yielding a desirable red print in a cone 10 reduction firing.

The use of copper as a colorant leads to several color possibilities depending on the firing procedure. Attempts were made to obtain a copper luster on several raku pieces, but the reduction apparently was insufficient, causing the print to stay green.

ENTRY 8: "Fat Man and Lady Cut Vase"

Stoneware, cone 10, lowfire glaze

Colorant: Emulsion containing 2 grams of colemanite

Exposure time: 25 minutes

Development time: 10 minutes

The tests using the fluxes, colemanite and borax, were not successful. The purpose of the tests was to attempt to add a fluxing material to the emulsion to create an emulsion

that would act as a glaze and, therefore, would not require the addition of a glaze to seal the image.

The emulsion used on "Fat Man and Lady Cut Vase" contained 2 grams of colemanite. This was not a sufficient amount of colemanite to cause the emulsion to fuse. The image did remain visible after firing to cone 10, but that was due to the potassium dichromate and not the colemanite.

Attempts on several prints were made using borax in the emulsion. The borax was ground to a fine powder, then added to the emulsion in 3 gram and 5 gram amounts. When added to the emulsion, the borax seemed to combine with itself, forming small balls of the material thus making the application of the emulsion more difficult. None of the prints attempted using borax developed correctly. Therefore, I never had a chance to fire a borax print to see if it might fuse.

The fourth question of the investigation dealt with the effect of firing on the test emulsions. The firing step was considered an essential part of the process because the firing of the print made it a permanent print.

I found that the gum-bichromate print could be fired to permanency by three methods: unglazed, glazed without the gum arabic burned out, and glazed with the gum arabic burned out. These three methods broadened the scope of uses of the gum-bichromate print on clay for creative purposes.

The relief print achieved when the gum arabic was not burned out was an unexpected result of firing. An example of this is "Guitar Man Wallpiece", one of the pieces on which a thicker coating of emulsion was used causing the glaze to peel back. I believe the relief print can only be achieved using the gum-bichromate process.

During the investigation, I found that even though a print looked satisfactory prior to glaze firing, the print sometimes became lighter when it was glaze fired. This effect was quite evident in the slide of "Torso Teapot #3".

ENTRY 9: "Torso Bowl #2"

Stoneware, cone 10

Colorant: Emulsion containing 1.5 grams of black copper oxide

Exposure time: 60 minutes

Development time: 15 minutes

The developed image on "Torso Bowl #2" was a very good print, but when fired to cone 10 unglazed, the image disappeared completely. This piece was the only piece where the print disappeared.

After the cone 10 firing, the unglazed surface was recoated with emulsion and another exposure was attempted. The image was quite clear after exposure, but during development the image began to wash out completely. I stopped the development at that point. The image was then glazed

with a lowfire glaze and fired to cone 06. There was no apparent explanation for the disappearance of the print. I assumed that the colorant burned out with the gum base and simply fell off the surface.

CHAPTER III

SUMMARY AND CONCLUSIONS

I began the experiments with the gum-bichromate because the method had not been, but conceivably could be, used on clay, would require fewer steps for completion than other photoclay processes (provided it worked), and would allow me to combine the media of clay and photography while retaining the basic elements of both.

This investigation was aimed at answering the four questions as posed in Chapter I, thereby refining the process. While I learned a great deal about the process, I did not achieve the degree of refinement that I had intended. For example, four tiles made of the same clay were bisque fired to the same temperature, coated with the same emulsion at the same time, exposed for the same length of time, and developed at the same time. Two of the tiles developed with clear images, but the emulsion on the other two tiles washed out completely. There was no explanation for the different results and the reasons are still unknown.

During the investigation, I became more interested in combining a nonutilitarian piece with a photograph than in combining a utilitarian piece with a photograph. The main

purpose of a nonutilitarian object is to provide stimulus for visual response. My personal feeling is that a photographic image on an object enhances the visual response to it. The main purpose of a utilitarian piece, such as "Torso Teapot", is its function. The photographic image is secondary to the function, and therefore appears to be less compatible.

As a result of this investigation, I am able to conclude that most ceramic oxides and stains can be added to the gum-bichromate emulsion as colorants. With regard to the use of fluxes and glazes in the emulsion, the number of tests attempted was insufficient to form a definite conclusion.

This investigation supports my conclusion that the gum-bichromate process is a viable method for reproducing a photographic image on a clay surface, and has given me valuable information which should prove to be a major influence on my future work.

APPENDIX A

GUM-BICHROMATE FORMULA

1. Mix separately:

   a. 1 ounce (dry weight) gum arabic to 2 ounces of warm water

   b. ½ ounce (dry weight) ammonium dichromate to 5 ounces of warm water.

2. Mix a. and b. together in a ratio of 1:1 (i.e., 1 ounce gum arabic to 1 ounce ammonium dichromate).

3. Add an amount of dry metallic oxides for color. Usually 2 or more grams gives sufficient saturation; iron oxide requires 3 or more grams.

APPENDIX B

LIST OF SLIDES

1. Photo pots in bisque state
2. "Torso Teapot"
3. "Guitar Man Box"
4. "Flamingo Wallpiece"
5. "Flamingo Lamp"
6. "Guitar Man Wallpiece"
7. "Fat People Wallpiece"
8. "Guitar Man Box #2"
9. "Transvestite Lidded Box"
10. "Townscape Picture Frame"
11. "Fat Lady Cone Vase"
12. "Jesus Has A Better Life"
13. "Torso Teapot #3"
14. "Randolph Grocery Lidded Box"
15. "Fat Man and Lady Platter"
16. "Fat Man and Lady Cut Vase"
17. "Torso Bowl #2"

BIBLIOGRAPHY

Eder, Josef Maria, History of Photography, New York, Columbia University Press, 1945.